- At each frequency, the phase of the noise spectrum is totally uncertain: It can be any value in between 0 and 2π, and its value at any frequency is unrelated to the phase at any other frequency.
- When noise signals arising from two different sources add, the resultant noise signal has a power equal to the sum of the component powers.

Because of the emphasis here on frequency-domain power, we are led to define the **power spectrum**. Because of Parseval's Theorem9, we define the power spectrum P_S *(f)* of a non-noise signal *s (t)* to be the magnitude-squared of its Fourier transform.

$$P_s(f) \equiv (|S(f)|)^2$$

(6.21)

Integrating the power spectrum over any range of frequencies equals the power the signal contains in that band. Because signals **must** have negative frequency components that mirror positive frequency ones, we routinely calculate the power in a spectral band as the integral over positive frequencies multiplied by two.

$$Power\ in\ [f_1, f_2] = 2\int_{f_1}^{f_2} P_s(f)df$$

(6.22)

Using the notation *n (t)* to represent a noise signal's waveform, we define noise in terms of its power spectrum. For white noise, the power spectrum equals the constant

$$\frac{N_0}{2}$$

With this definition, the power in a frequency band equals $N_0 (f_2 - f_1)$.

When we pass a signal through a linear, time-invariant system, the output's spectrum equals the product of the system's frequency response and the input's spectrum. Thus, the power spectrum of the system's output is given by

$$P_y(f) = (|H(f)|)^2 P_x(f)$$

(6.23)

This result applies to noise signals as well. When we pass white noise through a filter, the output is also a noise signal but with power spectrum

$$(|H(f)|)^2 \frac{N_0}{2}$$

6.9 Channel Models

Both wireline and wireless channels share characteristics, allowing us to use a common model for how the channel affects transmitted signals.

- The transmitted signal is usually not filtered by the channel.